CLINICAL PRACTICE

# Carbohydrate loading in the preoperative setting

**L T Hill, M G A Miller**

*Lauren Hill is a critical care dietitian with a PhD in physiology and 20 years' experience as a clinical dietitian, academic and researcher. Her special interest, knowledge and expertise is in nutritional support of critically ill adults, trauma patients and difficult-to-treat patients who have undergone surgery to the gastrointestinal tract. Malcolm Miller is a specialist anaesthetist and intensivist in clinical and academic practice at the University of Cape Town/Groote Schuur Hospital, South Africa. Nutritional support of the critically ill is among his interests. Both authors are affiliated to the Division of Critical Care and Department of Anaesthesia, Faculty of Health Sciences, University of Cape Town.*

Nutrition support is an evolving field, and modern clinical nutrition practice should actively incorporate strategies to enhance various clinical outcomes. In surgical patients, clinical benefits can be maximised by nutritional support protocols that minimise and manage the perioperative fasting period. This approach, which includes the perioperative provision of clear carbohydrate-containing fluids, has been shown to be safe, is evidence based, and is supported by many professional societies. Such a strategy has been shown to aid the anaesthetic process and maintain an optimal metabolic state, including improved insulin sensitivity and blunted muscle catabolic activity. Some important consequences of this improved metabolic control include shorter hospital stay and fewer postoperative complications. A proactive multidisciplinary team approach is essential to use this nutrition support strategy with success across a hospital's surgical service.

*S Afr Med J* 2015;105(3):173-174. DOI:10.7196/SAMJ.8746

The past decade has seen an evolution in clinical practices and protocols governing perioperative fasting for elective surgical procedures. Various professional associations for both surgery (Enhanced Recovery After Surgery (ERAS)) and anaesthesiology (Canadian, American, European, and South African (SA) society guidelines) (Table 1) support more modern nil per mouth guidelines of 6 hours for solids and only 2 hours for clear fluids, even in some instances for some patient subgroups known to have delayed gastric emptying. It has been suggested that minimising the preoperative fasting period, by allowing the consumption of oral carbohydrate-containing clear fluids with or without protein, has a number of clinical advantages, including more stable haemodynamics during induction of anaesthesia, greater glycaemic stability, reduced lean tissue catabolism, and a more positive patient experience. Nevertheless, consistent compliance of anaesthetists with the updated recommendations to allow carbohydrate-containing clear fluids in the immediate preoperative period is low.[1] This short review addresses the issues of permitting preoperative free fluids in view of lack of associated risk, and actively encouraging preoperative consumption of carbohydrate-containing free fluids due to the associated clinical benefits.

## Aspiration risk

The main rationale for maintaining patients in a preoperative fasted state is the purported risk of pulmonary aspiration upon induction of anaesthesia. In fact, the incidence of aspiration is very low – perhaps 1/45 000 elective anaesthetics in stable, otherwise healthy patients – and clinically important consequences of such an event are even rarer. It has been shown that gastric residual volume is a very poor marker of

**Table 1. Summary of professional association guidelines for preoperative fasting**

| Professional body | Current guideline |
|---|---|
| European Society of Anaesthesiologists | Adults and children should be encouraged to drink clear fluids (including water, pulp-free juice and tea or coffee without milk) up to 2 hours before elective surgery (including caesarean section). |
| ERAS | Preoperative clear fluid intake (exclusions from free intake according to national guidelines): 800 ml carbohydrate-rich drink the evening before surgery, and 400 ml 2 hours before anaesthesia. |
| Association of Anaesthetists of Great Britain and Ireland | Intake of water up to 2 hours before induction of anaesthesia. A minimum preoperative fasting time of 6 hours for food (solids, milk and milk-containing drinks). |
| European Society for Parenteral and Enteral Nutrition | Patients undergoing surgery who are considered to have no specific risk for aspiration may drink clear fluids until 2 hours before anaesthesia. Solids are allowed until 6 hours before anaesthesia.<br>Use preoperative carbohydrate loading (the night before and 2 hours before surgery) in most patients undergoing major surgery. |
| American Society of Anesthesiologists | Fast from intake of clear fluids (water, fruit juices without pulp, carbonated beverages, clear tea, coffee) at least 2 hours before anaesthesia. Fast from intake of light solids and non-human milk 6 hours before anaesthesia. Fast for 8 hours following fatty meals. |
| Canadian Anesthesiologists' Society | Before elective anaesthesia, duration of fasting should be 8 hours after a meal including meat or fatty foods, 6 hours after light solid meals, and 2 hours after clear fluids. |
| South African Society of Anaesthesiologists | Fasting guidelines of 6 hours for solids and 2 hours for clear fluids should be applied. |

aspiration risk, and that, with the exception of meals with a high fat content, intake of non-particulate meals such as carbohydrate-based drinks has no relevant bearing on increasing gastric residual volume. In fact, the opposite may be true: judicious use of appropriate oral fluids during the preoperative hours may actually reduce volume residue in the stomach.[2] The emphatic, traditional practice of prolonged preoperative fasting as a risk-reduction approach is therefore unnecessary and is a dogma not founded upon good evidence.

## The metabolic response to surgery

The typical physiological response to surgery includes a well-described stress hormone- and cytokine-induced hyperglycaemic and catabolic metabolic profile. This occurs in part as a result of poor movement of GLUT4 glucose transporters to the cell membrane, leading to insulin resistance, along with low muscle glycogen synthetase activity, leading to poor glycogen storage, in a counter-regulatory hormonal environment that enhances muscle protein degradation due to glucoeneogenesis. The response can persist for days to weeks after surgery, and its amplitude is influenced by the magnitude and duration of the surgery and the extent of intraoperative blood loss.[3] Both nutritional compromise going into surgery and the fasting state worsen the response, owing to underlying glycogen and lean tissue depletion.

In the SA clinical setting, poor nutritional status of surgical patients is common. It is generally advocated that purposive nutritional support of such patients in the pre- and perioperative period is of clinical benefit. However, the intentional use of nutrition-providing clear fluids in the acute preoperative phase, regardless of nutritional status, may not be practised as uniformly. This is despite the support for such practice by both the American and European societies for parenteral and enteral nutrition, as outlined in their guidelines.[4,5]

## The carbohydrate loading concept

Control of the metabolic response is understood to improve clinical outcomes. One of the recommended methods of control is the provision of isotonic, carbohydrate-containing clear fluids until 2 hours preoperatively, so that patients enter surgery in a fed rather than fasted state. This has been called 'carbohydrate loading'. The principle of the approach is the provision of an energy-containing liquid meal, which will result in insulin secretion necessary to alter the fasted metabolic state.[6] Since fat and hypertonic fluids inhibit gastric emptying, for safety reasons the preferred energy source is carbohydrate in an isotonic solution.

An amount of 50 g is sufficient to produce an insulin response similar to that of a mixed solid meal. Recommendations for preoperative carbohydrate loading have therefore been based around this amount and include 100 g carbohydrate on the evening prior to surgery and a further 50 g 2 hours prior to induction of anaesthesia.[7] There is now more than one commercially available sip drink oral supplement that can provide this amount in the form of complex carbohydrate polymers without providing excessive fluid or producing a hyperosmolar product. The isotonic nature of the sip drink is important, as hyperosmolar solutions may delay gastric emptying or provoke other gastrointestinal symptoms such as diarrhoea. Several thousand patients in clinical trials and several million patients in routine clinical practice worldwide have used these commercial carbohydrate-rich drinks without adverse events. The use of such products is therefore safe.

Both carbohydrate and protein produce the desired insulin response. It has therefore been postulated that the addition of protein to carbohydrate-rich sip drinks would enhance the clinical benefits of carbohydrate loading. Importantly, by using non-particulate, fat-free, lactose-free protein sources, carbohydrate drinks containing medical nutrition therapy-grade protein still meet the characteristics of a 'clear' fluid.

## Clinical benefits

Benefits of the above approach to preoperative fasting are both physiological and patient orientated. The physiological consequences of intake of carbohydrate-rich sip drinks up to 2 hours before surgery are an up to 50% reduction in insulin resistance, which in turn shortens hospital stay and reduces postoperative complications;[6,8] lower muscle catabolism;[9-11] improved intraoperative haemodynamic stability, particularly in children, as a result of more favourable fluid balance status; reduced days to discharge fitness; and superior handgrip strength, a sensitive marker of early muscle protein loss. Perrone *et al.*,[12] in a small study in 2011, showed that the addition of whey protein to a carbohydrate drink further improved insulin sensitivity and reduced acute-phase markers compared with carbohydrate alone. In addition, benefits on various aspects of patient comfort (such as thirst and anxiety), co-operation, compliance and overall subjective satisfaction have been reported.

## Conclusion

There has been a distinct shift in the clinical approach to optimally preparing patients for surgery. There is mixed but good evidence that preoperative oral carbohydrate delivery up to 2 hours before induction should be part of this optimising, and improves outcomes. This practice is widely supported by professional societies for nutrition, surgery and anaesthesiology, and therefore requires co-operative participation from the relevant members of the clinical team. However, it appears that compliance may not be ideal. A change in culture is still necessary so that practice is based on evidence rather than the beliefs or fears of individual practitioners working defensively. Better implementation may depend not only on increasing awareness of modern fasting guidelines but also on packaging nutrition interventions like this one into audit bundles in order to incentivise compliance through a systems-based approach. The time has come for consistent metabolic preparation of patients in the preoperative period through delivery of carbohydrate loading in order to improve surgical outcomes.

**Disclosures.** LH received an unrestricted writing grant from Nestlé Healthcare, SA.

1. Bosse G, Breuer JP, Spies C The resistance to changing guidelines – what are the challenges and how to meet them. Best Pract Res Clin Anaesthesiol 2006;20(3):379-395. [http://dx.doi.org/10.1016/j.bpa.2006.02.005]
2. Maltby JR. Fasting from midnight – the history behind the dogma. Best Pract Res Clin Anaesthesiol 2006;20(3):363-378. [http://dx.doi.org/10.1016/j.bpa.2006.02.001]
3. Nygren J. The metabolic effects of fasting and surgery. Best Pract Res Clin Anaesthesiol 2006;20(3):429-438. [http://dx.doi.org/10.1016/j.bpa.2006.02.004]
4. McClave SA, Martindale RG, Vanek VW, et al.; A.S.P.E.N. Board of Directors; American College of Critical Care Medicine; Society of Critical Care Medicine. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). JPEN J Parenter Enteral Nutr 2009;33(3):277-316. [http://dx.doi.org/10.1177/0148607109335234]
5. Weimann A, Braga M, Harsanyic L, et al. ESPEN guidelines on enteral nutrition: Surgery including organ transplantation. Clin Nutr 2006;25(2):224-244. [http://dx.doi.org/10.1016/j.clnu.2006.01.015]
6. Ljungqvist O. Modulating postoperative insulin resistance by preoperative carbohydrate loading. Best Pract Res Clin Anaesthesiol 2009;23(4):401-409. [http://dx.doi.org/10.1016/j.bpa.2009.08.004]
7. Kratzing C. Pre-operative nutrition and carbohydrate loading. Proc Nutr Soc 2011;70(3):311-315. [http://dx.doi.org/10.1017/S0029665111000450]
8. Sato H, Carvalho G, Sato T, Lattermann R, Matsukawa T, Schricker T. The association of preoperative glycemic control, intraoperative insulin sensitivity, and outcomes after cardiac surgery. J Clin Endocrinol Metab 2010;95(9):4338-4344. [http://dx.doi.org/10.1210/jc.2010-0135]
9. Donatelli F, Corbella D, Di Nicola M, et al. Preoperative insulin resistance and the impact of feeding on postoperative protein balance: A stable isotope study. J Clin Endocrinol Metab 2011;96(11):E1789-E1797. [http://dx.doi.org/10.1210/jc.2011-0549]
10. Henriksen MG, Hessov I, Dela F, et al. Effects of preoperative oral carbohydrates and peptides on postoperative endocrine response, mobilization, nutrition and muscle function in abdominal surgery. Acta Anaesthesiol Scand 2003;47(2):191-199. [http://dx.doi.org/10.1034/j.1399-6576.2003.00047.x]
11. Yuill KA, Richardson RA, Davidson HI, et al. The administration of an oral carbohydrate-containing fluid prior to major elective upper-gastrointestinal surgery preserves skeletal muscle mass postoperatively – a randomised clinical trial. Clin Nutr 2005;24(1):32-37. [http://dx.doi.org/10.1016/j.clnu.2004.06.009]
12. Perrone F, da-Silva-Filho AC, Adôrno IF, et al. Effects of preoperative feeding with a whey protein plus carbohydrate drink on the acute phase response and insulin resistance: A randomized trial. Nutr J 2011;10:66. [http://dx.doi.org/10.1186/1475-2891-10-66]

*Accepted 11 August 2014.*